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**PINE STREET CANAL SUPERFUND SITE
BURLINGTON, CHITTENDEN COUNTY, VERMONT**

HISTORIC RESOURCES STUDY

John Milner Associates
Architects • Archeologists • Planners

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HISTORIC RESOURCES STUDY

Prepared for

de maximis, inc.
135 Beaver Street
Fourth Floor
Waltham, Massachusetts 02454

By

Douglas C. McVarish
Joel I. Klein, Ph.D., RPA
J. Lee Cox, Jr.

JOHN MILNER ASSOCIATES, INC.
One Croton Point Avenue
Croton-on-Hudson, New York 10520

In association with

DOLAN RESEARCH, INC.
4425 Osage Avenue
Philadelphia, Pennsylvania 19104

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MANAGEMENT SUMMARY

This document constitutes the Historic Resources Study for the Pine Street Canal Superfund Site (the Site) in the City of Burlington, Chittenden County, Vermont. It has been prepared in partial fulfillment of the requirements of a Consent Decree entered into by the United States District Court for the District of Vermont, and relating to the implementation of remediation measures at the Site. The Site is located on the Burlington waterfront west of Pine Street and consists of approximately 38 acres within a larger 70-80 acre Study Area. The principal remediation measure is the placement of a subaqueous cap over contaminated sediments in Pine Street Canal and its associated turning basin.

This report evaluates the effects of the implementation of remediation measures on significant and potentially significant historic resources at the Site and discusses possible mitigation measures where appropriate. Potentially affected resources include the Pine Street Barge Canal itself, several canal boats sunk in the canal, and remains of two boathouse/marine railways. Also evaluated, at the request of the Vermont Division for Historic Preservation (VDHP), are two properties related to the canal—a drawbridge and breakwater remains. An update of a previous evaluation of prehistoric archeological sensitivity is also included, as requested by VDHP.

In the opinion of JMA, the Pine Street Barge Canal will be adversely affected by implementation of the selected remedy. Potential mitigation measures include preparation of a public history brochure describing the history and significance of the Canal and its associated resources. In the opinion of JMA the canal boat wrecks are significant and will also be adversely affected. Recommended mitigation includes documentation of other canal boats located off-site and the preparation of associated historic documentation on this resource category.

The remains of the boathouses associated with the marine railway constitute a potentially significant archeological site. To insure that the boathouse remains are not affected by the project, JMA recommends that the boundaries of the area containing the visible aboveground remnants of the boathouses be identified. Following boundary delineation this area should be fenced for the period of project-related construction to insure that it is not inadvertently encroached upon. In the opinion of JMA, the placement of a small quantity of soil on top of possibly buried boathouse remnants (south of the visible remains) to cap contamination in this area will not adversely affect those remains if the soil is deposited in a manner that does not require heavy equipment to traverse areas which have not already been covered by the clean fill. No mitigation relating to the submerged portions of the marine railways is recommended.

No construction activities associated with the proposed remedy are currently identified as occurring at the location where aboveground remnants of the boathouses were observed by JMA (see Section 3.3). However, the approximately 100 x 100-foot wetland area which will be covered with clean soil (see Figure 4) is located immediately south of the visible remains. According to Sanborn maps, the southern ends of both boathouses extended into this area. In the opinion of JMA, subsurface investigation of this area to confirm the presence of additional boathouse remains is not warranted.

The abutments of the existing drawbridge will be affected by the installation of a new concrete abutment placed against the canal-facing side of each of the two existing drawbridge abutments. This will result in a change in the appearance of the drawbridge abutments that could be considered an adverse effect. However, the physical integrity of the existing abutments will not be affected and, given the scale and industrial nature of the resource, the visual effect is

considered minor. Large format photography to Historic American Engineering Record (HAER)-standards is recommended as mitigation. The breakwaters will not be directly affected by the implementation of the selected remedy.

A re-evaluation of the prehistoric archeological sensitivity of the Site indicates that it is covered by fill deposits ranging from 5 to 25 feet thick. It is therefore highly unlikely that any prehistoric archeological remains would be affected by implementation of the proposed remedy.

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Abstract

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1.0 INTRODUCTION

1.1 Site/Project Location and Site Description

The Pine Street Canal Superfund Site (the Site) is located in the southern portion of the Burlington, Vermont waterfront between Pine Street and the shore of Lake Champlain (Figure 1). It consists of a currently vacant 38-acre area where contaminants associated with wastes from a manufactured gas plant have been found (Figures 2 and 3). It is located within a larger 70- to 80-acre Study Area that is bounded by Lakeside Avenue on the south, Pine Street on the east, Vermont Railway property on the north, and the Vermont Railway and Lake Champlain on the west.

The Site includes the surviving south portion of the Pine Street Barge Canal, the turning basin for the canal, and the outlet for the canal into Lake Champlain. The former north and south slips of the barge canal have been partially or completely filled. Other structures located within the project area are a steel railroad bridge across the outlet of the barge canal, the remains of stone breakwaters extending from either side of the outlet into the lake, and the remains of marine railways on the south side of the turning basin. A recently constructed Quonset hut storage building is located west of the canal and south of its outlet.

Access to much of the Site is difficult. The area east of the barge canal is largely overgrown, with few paths through the undergrowth. A path from the rear of the Maltex Building parking lot allows access to a section of the east portion of the canal, and a tributary path permits limited access to the south side of the turning basin. Access to the east side of the turning basin is possible in the rear of the former Citizen Oil Company property. Access to the west side of the barge canal is limited because of an active railroad right-of-way. A bicycle path extends along the lakefront west of the project area.

1.2 Project Background and Description

The Site was listed on the National Priorities List in 1983, and in 1992 the U.S. Environmental Protection Agency (USEPA) proposed a cleanup plan for the site. USEPA withdrew its proposal in 1993. After consideration of comments from environmental regulators, the potentially responsible parties (PRPs), citizen groups, and the general public, USEPA proposed a new remedy and issued its final Record of Decision (ROD) in September 1998. As part of a legal action brought by USEPA and the State of Vermont against the PRPs pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), a group of the PRPs (the Settling Defendants) entered into a consent decree with USEPA and the State of Vermont. The consent decree calls for a group of the Settling Defendants, the Performing Defendants, to implement the proposed remedy.

The alternative (Alternative 3A) identified in the ROD as the selected remedy provides for capping of contaminated sediments in all areas where unacceptable ecological risk has been found, effectively isolating the contamination below the biologically active zone. Long-term performance monitoring of groundwater, surface water, stormwater, sediments and the caps is required along with the initiation of institutional controls.

Subaqueous caps are to be placed in Subareas 1, 2, and 8 of the Site, and a cap is to be constructed in the emergent wetlands in Subareas 3 and 7 (Figure 4). Subareas 1, 2 and 8

constitute what remains of the Pine Street Canal and its associated turning basin. The subaqueous cap in these subareas will be constructed of layers of sand (Figures 5, 6, and 7). It is expected that the sand will consist of medium to fine sand with a maximum particle size of 3/8 inch and less than 5 percent fines. A final cap thickness of 1.5 to 2.0 feet above the current bottom elevation is anticipated, but 2.5 to 3 feet of capping material may be required to attain final cap thickness after settling and consolidation occurs. It is not expected that excavation of existing bottom sediments will be required. If this is found to be necessary sediments will be dredged from the canal and transported to the turning basin for on-site placement. The cap placed over the sediments in Subareas 3 and 7 will be a combination of sand and wetland soil or topsoil uncontaminated with exotic plant seeds and containing 3-4 percent organic matter.

In addition to Subareas 1, 2, 3, 7, and 8, clean soil will be placed in an approximately 100 x 100-foot area immediately south of the turning basin (Figure 4). Elevated concentrations of compounds of concern were detected in shallow sediments in this area of emergent wetlands.

Associated with the cap design is the construction of a permanent weir at the mouth of the turning basin where it enters Lake Champlain. This weir will help maintain a water level of 96 feet above MSL or greater and will help to reduce the potential for cap erosion. Weir design will include the installation of a new concrete abutment on either side of the canal basin outlet for the purpose of anchoring the weir. Each new abutment will be placed against the canal-facing side of each of the two existing drawbridge abutments.

Construction of the caps will involve the following steps:

- mobilization and site preparation;
- site clearing to remove trees, brush and grass from the cap area;
- construction of the weir and a temporary turbidity curtain over the mouth of the canal;
- excavation of sediments from areas to be capped, if required to maintain wetlands functions, with disposal in the turning basin;
- construction of the subaqueous cap;
- wetland restoration or replacement; and
- site restoration.

Figure 8 shows possible area where clearing of trees and brush will be required in order to provide access to work areas, storage areas for materials, and staging and work areas for equipment. The subaqueous cap will be constructed of sand. A limited number of areas around the Canal and turning basin will be required as staging areas for receiving sand and delivering it to the barges placing the sand in the Canal. The sand will be delivered from the staging area to the barges via a telescoping conveyor. The cap over Subareas 3 and 7 will be placed using conventional earth-moving equipment.

1.3 The Historic Resources Study

A Stage IA cultural resources survey of the Study Area was carried out by John Milner Associates, Inc (JMA) in 1992 (Cook and McCarthy 1992). That study reported that previously identified cultural resources within the limits of what is now the Site, include the Pine Street Canal and eight canal boats sunk in the canal. The Canal has been determined by the Vermont State Historic Preservation Officer (SHPO) to be eligible for the National Register of Historic Places (NRHP). At the time of the Phase IA survey, SHPO considered the canal boats to be

potentially eligible for the NRHP but felt that more documentation was needed before a conclusive evaluation could be made. The Phase IA survey also identified a marine railway, and a drawbridge at the mouth of the canal turning basin, as potentially significant cultural resources. The IA survey also identified areas of archeological sensitivity within the Study Area (Figure 9).¹

In 1996 underwater archeological investigations were undertaken at the Pine Street Canal (Cohn 1996). A side scan sonar survey, in conjunction with a remotely operated vehicle (ROV) survey and diving, identified the remains of five vessels and two marine railways. The report also indicated that the remains of "at least three additional vessels are located in the southern canal but buried under several feet of sedimentation" (Manley et al. 1996:3).

As part of the consent decree the Performing Defendants are required to submit to the USEPA and the Vermont Department of Environmental Conservation a Historical Resources Study. The Historical Resources Study is intended for use by USEPA and SHPO in complying with their obligations under Section 106 of the National Historic Preservation Act (NHPA), which USEPA has determined is an Applicable or Relevant and Appropriate Requirement (ARAR) under CERCLA.

The consent decree calls for the Historical Resources Study to "examine the potential resources (barges, marine railways) present in the canal and turning basin that will be affected by the selected remedy . . . [and] determine whether the barges and marine railways are eligible for listing on the National Registry (sic) of Historic Places." The consent decree also requires the Historic Resources Study to include "a determination of what level of mitigation may be required to mitigate the effect."

On June 29, 2000, SHPO staff requested that the scope of the Historic Resources Study be expanded to include an updated evaluation of the archeological sensitivity study prepared in 1992, documentation necessary to support the SHPO's prior determination of NRHP eligibility for the Pine Street Canal, and information about the drawbridge and breakwater at the Site.

This document constitutes the Historic Resources Study.

¹ The Phase IA survey also noted that the Queen City Cotton Company plant, now owned by General Dynamics, has been determined by the SHPO to be eligible for NRHP. It also noted that other potentially significant historic resources within the Study Area include a prehistoric site (VT-CH-81) located between the Vermont Railway and Lake Champlain, the Maltex Building complex west of Pine Street, and possible archeological remains associated with a non-extant nineteenth century planing mill which was located south of the Maltex complex. All of these locations are outside the Site boundary.

2.0 METHODS

Documentary research to collect information about the historic resources at the Pine Street Canal Superfund Site was conducted in the following repositories: the Special Collections, Bailey-Howe Library, University of Vermont, Burlington; the Fletcher Free Library, Burlington; the Vermont Historical Society Library, Montpelier; the Vermont Division of Public Records; the Vermont Division for Historic Preservation; and the Lake Champlain Maritime Museum, Vergennes. Information reviewed and evaluated included insurance maps (such as those published by the Sanborn Map Company), newspaper articles (some of which were identified from indices in the Special Collections, Bailey-Howe Library), published and unpublished local historical accounts, property records, and interviews with knowledgeable residents.

Documentary research was supplemented by field visits to the Site during the summer of 2000. A path from the rear of the Maltex Building parking lot allowed access to a section of the east portion of the canal, and a tributary path permitted limited access to the south side of the turning basin. Access to the east side of the turning basin was possible in the rear of the former Citizen Oil Company property. Access to the west side of the barge canal is limited because of an active railroad right-of-way. The west side of the turning basin of the barge canal was examined in the vicinity of the outlet.

3.0 HISTORIC RESOURCE DESCRIPTIONS

Historic resources located within the boundaries of the Pine Street Canal Superfund Site include the Pine Street Barge canal itself; a Strauss trunnion bascule bridge that extends across the mouth of the barge canal; breakwaters that extend into Lake Champlain on either side of the barge canal mouth; the remains of former marine railways/boathouses on the south bank of the canal turning basin; and remains of at least five canal boats sunk in the Canal and turning basin. A VDHP complex form has been prepared for the canal, the bridge, the breakwaters, and the boathouses. This form is included as Appendix I.

3.1 The Pine Street Barge Canal

The Pine Street Barge Canal (Plates 1 to 6) represents the remnants of an originally larger resource. A series of historic maps included in this report clearly show the canal as it appeared in the nineteenth and early to mid-twentieth centuries. As shown in Figure 9, the north and south barge slips have been filled in, the south portion of the main canal has been narrowed, and a portion of the turning basin has silted in. The outlet connecting the turning basin to Lake Champlain remains relatively intact. The canal basin is lined with boulders, many of which have been displaced from their original locations.

Most of the shore of the canal is now overgrown with trees, shrubs, and vines. Originally a strictly geometrical body of water, the shoreline is now less regular due to erosion, filling, and the partial collapse of bulkheads. Originally a maximum of eight feet deep, the depth of at least some portions of the waterway have been reduced.

The shoreline of the canal was originally surrounded by a dike, possibly constructed of rubble. The inner side of this dike was finished with planking. According to an area resident, planking or cribbing is visible along the southern reaches of the canal during times of low water (as cited in Cook and McCarthy 1992). Visible remains include piled rubble along the shore that may have been originally used to form the dike.

3.2 The Canal Drawbridge

The first bridge across the outlet of the canal basin was constructed to carry the tracks of the Champlain Valley Railroad (later the Rutland Railroad). In 1847, Timothy Follett, president of the Rutland and Burlington Railroad, acquired land along the Lake Champlain waterfront for a railroad right-of-way (Visser et al. 1990:25). The first tracks along the Burlington waterfront were laid in 1849, creating a direct link between Lake Champlain and New England markets and manufacturing centers (Crisman 1990:19).

The original drawbridge across the entrance to the canal basin was a single-track structure built of wood. In 1893, it was replaced by an iron gallows framed, jack knife drawbridge (Blow 1991:97). The gallows frame was constructed of 10-inch channel beams laced with 3 ½ inch bars, and was supported by a series of angled steel rods extending from the frame down to the bridge deck (Figure 10). The present steel trunnion bascule bridge was designed in 1919 by the Strauss Bascule Bridge Company of Chicago, one of the nation's leading designers of drawbridges (Figure 11). Steel for the bridge was manufactured by the Pennsylvania Steel Company (later Bethlehem Steel Company) of Steelton, Pennsylvania.

The term “bascule” is taken from the French word for “see-saw.” A bascule bridge features a movable leaf which rotates on a horizontal hinged axis (a trunnion) to raise one end vertically. A bascule bridge employs a large counterweight to offset the weight of the raised leaf (Cridlebaugh 1999).

3.2.1 Strauss Bascule Bridge Company

The first Strauss bascule bridge, built for the Wheeling and Lake Erie Railroad and spanning the Cuyahoga River, was completed in 1905. This bridge design was patented by Joseph B. Strauss, and later patents were controlled by the bridge company. By the 1920s, more bascule bridges had been built to Strauss designs than from those of any other single type of bascule (Hovey 1926:115-116).

The Strauss Bascule Bridge Company produced several basic designs for its bridges. Types produced by the company included the vertical overhead counterweight type, the underneath counterweight type, and the heel trunnion type. The barge canal bridge is an example of the first type. The overhead counterweight type of bridge is illustrated in a figure in Hovey’s *Movable Bridges*. The operation of the vertical counterweight bridge is described in that publication as follows (Figure 12):

The center of gravity of the moving leaf is at g and that of the counterweight at g' . Trunnion A and joint B are in the same plane as g and link CD is parallel to gAB . $ABCD$ is a parallelogram. Hence, in any position, closed or in motion, $Px = Wy$, or $Px' = Wy'$; and a balance is maintained throughout the movement of the leaf. In this type the dead load on the trunnion is $P + W$, and the reaction is always positive and constant. The introduction of the parallelogram permits the center of gravity of the counterweight to be at any convenient height above B , while in a simple trunnion bridge it must be at B , in the plane of gAB . The break in the floor is in front of the trunnion (Hovey 1926:116).

An overhead counterweight bridge similar in scale to the barge canal bridge was that designed by the Strauss Company for the Chambly Canal at St. Johns, Quebec. This bridge spanned a clear channel of 70 feet and was powered by two, 7.5 hp motors (Hovey 1926:116).

3.2.2 The Barge Canal Bridge

The barge canal bridge (Plates 7 to 14) originally consisted of a steel-framed moving leaf with a main trunnion, counterweight trunnion, and concrete counterweight. A steel-framed tower extends across the width of the bridge and rises 38 feet from the base of the bridge. In its resting position, the leaf rested on poured concrete bridge seats anchored to the banks of the channel by pilings. The moving or bascule leaf, pivoted on a main trunnion mounted to the north bridge seat. Rising above the main trunnion is the trunnion tower. A link at the top of the tower connected to the counterweight trunnion and then to the counterweight. The counterweight was, in turn, connected to the tail trunnion on the tail of the moving leaf behind the main trunnion. The combination of power generated by the bridge engine and the shifting of the counterweight permitted the moving leaf to be raised and lowered. The moving leaf carries two railroad tracks across the 28-foot clear channel opening. The leaf is 18 feet wide.

The irregularly shaped, reinforced concrete counterweight is shown in Figure 13. The counterweight was mounted to the steel counterweight frame by a counterweight link, a riveted steel framework that measured 15 feet three inches long and six feet one inch wide. The counterweight has been removed from the bridge and presently rests on a site west of the bridge. The moving leaf is constructed of steel I-beam girders with steel laterals (Figure 14). The trunnions were mounted to steel-framed trunnion posts that measure 38 feet high (Figure 15).

Machinery enclosures were placed on both sides of the bridge beneath the bridge deck. These enclosures were fenestrated with three light windows. The enclosure walls are now gone and remaining portions of the machinery are clearly visible, mounted to a platform below the bridge deck.

The concrete slab operator's house measures 11 feet by eight feet in plan (Figure 16). Paired window openings are placed on the longer elevations. Each originally contained four-over-one, double-hung, sash windows. Single four-over-one, double-hung windows were placed in the shorter elevations. All window openings and frames are gone. Three-foot wide stairs extended from the north elevation of the operator's house down to the bridge deck. These stairs are also gone. The interior of the house contained a switchboard, a controller, and a lavatory. All interior furnishings have been removed. Its roof is sheathed in tar and gravel and flashed in galvanized iron. The operator's house is elevated above the machinery room by a steel substructure originally sheathed in asbestos but now uncovered.

The machinery enclosure originally consisted of asbestos-covered steel plate mounted to a light angle framing. The steel plates are now gone but the framing remains. The bridge was powered by an AC motor. Original specifications called for a General Electric 60 cycle, 220 volt, 3 phase, 5 horsepower motor operating at 900 RPM. The motor was to be equipped with a solenoid brake with a hand-operated mechanical release for use when the bridge was hand-operated. A series of shafts, flanges, and a rack and pinion connected the motor to the main trunnion (Figure 17). Rusty gears and shafts and the remains of a motor are still in place on the platform. It is highly unlikely that this machinery remains operational.

The Vermont Division for Historic Preservation determined the bridge eligible for listing in the National Register of Historic Places in March 1987. This determination was made in response to a request from the Vermont Agency of Transportation which had plans to modify the bridge. At that time, the decision was made that it would be acceptable to remove the concrete counterweight for the bridge, providing that the weight was left at the site so that its historic function could still be understood (Gilbertson 1988).

In March 1987, the counterweight for the bridge was removed and placed on the north shore of the barge canal outlet west of the bridge. Portions of the counterweight and associated steel framework remain in place. A portion of one side of the counterweight was cut away to permit the construction of the Burlington bicycle path bridge across the opening of the barge canal.

In the statewide bridge survey undertaken by Roth and Clouette, only one other drawbridge was identified, that which crosses Missisquoi Bay.

3.3 Marine Railways

Two structures (VT-CH-806), identified in a previous survey as marine railways (Cohn 1996), are located adjacent to the south side of the turning basin (Plates 15 to 18; Figure 18). Both structures

are in ruinous condition and are now largely hidden by undergrowth. Extant portions of the fabric of each structure include poured concrete ramp walls that extend downward into the south end of the turning basin and a series of parallel poured concrete footings. Timbers, probably either a portion of the shipway or a portion of the boathouse framing, lie on the ground in the vicinity of the concrete footings. No rails or remains of machinery were visible during a pedestrian reconnaissance of the area.

During a 1996 side scan sonar and ROV survey of the turning basin “two railroad tracks (each 2 m in width) were identified extending from the south edge and extending ~20 meters into the Turning Basin. These railway tracks are aligned with concrete walled cribs located on the southern shoreline of the Turning Basin” (Manley et al. 1996). These railways were located and measured during diving operations. Railway No. 1 extends 114 feet into the turning basin and then disappears into the mud of the basin bottom for an undetermined additional length. Railway No. 2 extends approximately 102.5 feet into the turning basin and then ends (Cohn 1996:2).

Early twentieth century Sanborn maps show two, wood-framed, one- and two-story boathouses in this location with ramps extending northward into the turning basin (Figure 19). No documentary evidence could be located about the date of construction and use of these structures. Cohn (1996:2) suggests that the structures were marine railways associated with the Proctor Boat Works, but does not provide the source of this information. Insurance maps of Burlington do not confirm this ownership nor do they identify the buildings as containing marine railways. On a 1926 Sanborn map, the west wood-framed boathouse is indicated as also being used for boat repairing. A single story, wood-framed, open lean-to had been appended to the east elevation (Figure 20). The boathouses are also shown on 1942 and 1955 Sanborn maps (Figures 21 and 22). None of the Sanborn maps indicate any machinery associated with the boathouses.

The concept of a marine railway, an inclined plane to be used for hauling ships onto land for repair was apparently developed in the early nineteenth century. Thomas Morton, an English shipbuilder, was granted a patent in 1819 for his “patent slip” consisting of the “application of a particular kind of carriage to the inclined plane.” The earliest marine railway in North America was erected in Salem, Massachusetts in 1823, and soon others were constructed in coastal waterfronts. Nearly all the initial marine railways relied upon horse or human power for hauling, but some employed steam power (Rumm n.d.:2).

A marine railway consists of three basic elements: 1) the inclined plane leading into the water; 2) the cradle upon which the boat rests; and 3) some form of windlass or winch for hauling the cradled ship up the incline. The facility also generally includes facilities for repairing ships (Rumm n.d.:3). In his HAER documentation for the marine railway at the Thames (Connecticut) Shipyard, Alex Gratiot described the cradle, the heart of the railway:

The cradle sat on rollers, which in turn rested on the iron strap rails. One set of stringers followed the incline of the plane, while another set on the lower two-thirds of the cradle supported a level working platform. This working platform was held above the stringers by heavy wood trusses. The space between the two sets of stringers was filled with scrap metal or fieldstone which served as ballast; it prevented the cradle from floating. Beams ran perpendicular to the longitudinal stringers and supported both the keel blocks, which bore almost all the weight of the ship on the cradle, and the sliding bilge blocks, which gave lateral stability to the craft. Winches for hauling the bilge block in and out from under the hull were placed on docking platforms on each side of the cradle supported by upright posts (as cited in Rumm n.d.:11).

Hauling a vessel up the railway involved substantial preparation. The cradle had to be adjusted to fit the hull of the craft. The craft was directed into position over the cradle arms, a delicate operation that often involved several attempts. The engine was powered up to haul the craft slowly along the ways. As the cradle ascended the railway, workers placed additional blocks under the ship's hull. Depending on the size of the ship and the means employed, hauling a ship up a railway could take from an hour to an entire day (Rumm n.d.:11-12).

Small shipways and marine railways were once located at various points along Vermont's lakefront. Many such structures lacked the machinery needed to haul boats back onto land and were used only to launch boats into the water. Few remain. The largest remaining marine railway in Vermont is presently located at the Shelburne Shipyard and is owned and operated by the Lake Champlain Transportation Company (Dumbleton 2001). This railway was one of two at the shipyard; the smaller one closed in the 1980s (Shelburne Shipyard 2001).

The railway replaced an earlier horse-powered structure (Cramer 1977). It was built by the Crandall Engineering Company of Boston and originally used two 150-horsepower steam engines to haul boats out of the water (Aske and Lane 1992:8). Opened on October 24, 1929, its cradle is 235 feet in length, 65 feet in width and weighs about 300 tons. The track upon which the cradle operates is approximately 800 feet in length. From its upper end to the water level, the track is built of reinforced concrete, and from the water line to its outer end, wood placed on piles. The rails consist of flat steel plates. The railway's original motive power was steam, the cradle operated by two steel hauling chains driven by a steam hoist. The engines were housed in a wood-framed building immediately beyond the inshore end of the track (Ross 1997:169). In recent years, the original steam engines have been replaced by electric motors but much of the rest of the 1929 structure remains intact (Dumbleton 2001). The railway has a capacity of 1,000 tons (Hill 1953:12).

3.4 Lake Champlain Breakwaters

Nineteenth and early twentieth century maps clearly show a pair of breakwaters located at either side of the barge canal outlet. A substantial portion of the south breakwater remains. This structure, constructed of stone slabs and rubble extends from the shore of the canal outlet in an arc westward into Lake Champlain.

On the north side of the outlet, the curve of the Lake Champlain shoreline is lined with rubble and a short rubble breakwater extends into Lake Champlain from the outer portion of the curve.

A short breakwater is shown extending from the north bank of the canal map on an 1869 map (Figure 23). A longer structure, indicated as a pier, extended from the south side of the canal mouth (Sanborn 1869). Later nineteenth century maps such as those by the U.S. Coast Survey (Ogden and Granger 1873) and Woodbury (1886) show breakwaters sheltering the mouth of the barge canal. These breakwaters extended the length of the south side of the mouth and along the angled north bank of the mouth east to the railway bridge abutment. These breakwaters were angled out into the lake with a northward turn at their outward ends. The breakwaters are shown on several Sanborn maps, most recently the 1955 edition. On that map, a tapering straight breakwater is shown angled northwest from the south side of the canal outlet and a longer breakwater is angled northwest from the point on the north side of the canal outlet (Figure 22).

Plates 19 and 20 show the breakwaters as they appeared in September 2000.

3.5 Pine Street Canal Boat Sites

Five wreck sites were located in the turning basin portion of the Pine Street Canal during a side scan sonar survey completed in 1996. Follow-up diving was conducted to identify the type of wrecks found on the sonar records. All five of the wrecks were canal boats of similar dimensions (97 ft. by 17.5 ft.). The report states that “while all the vessels are of the same basic size, dimension, and class, they all exhibit different construction characteristics and therefore are presumed to have been produced at different yards” (Cohn 1996:2).

Each of the wrecks appears to survive in a relatively good state of preservation. Vessel 1, located in the northeast corner of the turning basin, has concrete debris from the shoreline covering one end of the boat. Although only unscaled drawings are provided in the 1996 report, the other end and the sides of Vessel 1 (VT-CH-800) appears to be intact. An estimated three to four feet of silt cover the interior portions of the wreck. All of Vessel 2 (VT-CH-801) appears to remain intact. Vessel 2 is located along the eastern side of the turning basin. Similar to Vessel 1, the interior of the wreck is covered with an estimated two to three feet of sediment (Figure 5) .

Vessel 3 (VT-CH-802) lies parallel to the Vessel 2. The bow end of Vessel 3 is broken. Although the interior is covered with one to two feet of sediment, the sides of the boat appear to remain in a good state of preservation. Vessels 4 (VT-CH-799) and 5 (VT-CH-798) lie in a line on the west side of the turning basin. Vessel 5 is directly north of Vessel 4. Vessel 4 appears to be the best preserved of the group of wrecks in the canal. Portions of four interior bulkheads are depicted in the report and the bow and stern remain intact. Fewer details are provided for Vessel 5, but the site drawing indicates that the vessel remains relatively intact.